

# Supplementary Materials for “SDUIE: Semi-Supervised Diffusion for Underwater Image Enhancement with Quant-Text Dual Control”

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001 The supplementary materials include: (1) more experi-  
002 mental detail, ablation studies, and hyperparameter analy-  
003 sis, (2) more comparison results with existing algorithms,  
004 (3) more results of SDUIE-Quant, (4) more results of  
005 SDUIE-Text, and (5) more results of interpolation methods,

006 *Data preparation.* The datasets used for comparison en-  
007 hancement results include UCCS [4], EUVP [1] (the test  
008 set), U45 [3], and challenging-60 [2].

009 **Analysis of adversarial losses.** We remove the  $\mathcal{K}_{ie}$  and  $\mathcal{K}_{ir}$   
010 for adversarial training (w/o AT) and display the obtained  
011 images in Fig. 1. After removing the adversarial training  
012 process, both the color correction and detail restoration ca-  
013 pabilities are negatively affected as shown in the visual re-  
014 sults in Fig. 1.

015 **Analysis of hyperparameter sensitivity.** The hyperparam-  
016 eters involved in the training phase of the network include  
017 (1) the weights factors  $\lambda_1$  and  $\lambda_2$  of the loss function, and  
018 (2) the LoRA rank  $r_U$  (UNet) and  $r_V$  (encoder and decoder  
019 of VAE). Table 1 shows the changes of metrics under dif-  
020 ferent weight factors. The results show that SDUIE is not  
021 sensitive to  $\lambda_1$  and  $\lambda_2$ . Table 2 also shows that the perfor-  
022 mance of the models under different rank settings is quite  
023 close. These results collectively confirm the method’s ro-  
024 bustness to hyperparameter selection.

025 **More comparison results with existing algorithms.** Fig. 2  
026 shows more real-world visualization comparisons with ex-  
027 isting algorithms. The results verify that our algorithm can  
028 achieve visually impressive enhanced performance, which  
029 is consistent with the Main Paper.

030 **More results of SDUIE-Quant.** In Table 3, we provide  
031 the changes of evaluation metrics under different fusion fac-  
032 tors on challenging-60 [2] and U45 [3], where the results on  
033 UCCS [4] and EUVP [1] have been given in the Main Pa-  
034 per. Meanwhile, Fig. 3 shows the impact of changing the fu-  
035 sion factor on the enhancement level in more scenarios. The  
036 conclusions of quantitative and visual evaluation results are  
037 consistent with those in the Main Paper.

038 **More results of SDUIE-Text.** Table 5 presents the evalu-  
039 ation metrics across more datasets when applying different  
040 prompts. Meanwhile, Fig. 4 visually demonstrates prompt-

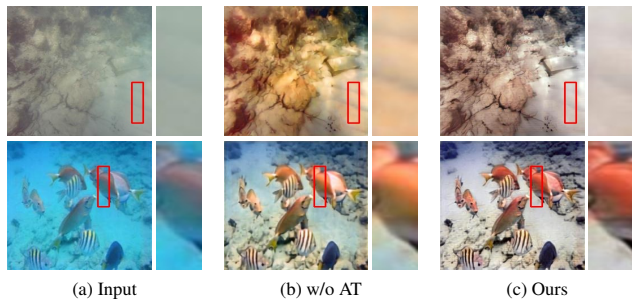


Figure 1. Ablation study of the process of the adversarial training (w/o AT).

Table 1. Evaluation of the sensitivity of performance to the weights of the loss function.

$\lambda_1 : \lambda_2$	1 : 2	1 : 4	1 : 6	1 : 8
UIQM $\uparrow$	-0.103	-0.112	<b>0.108</b>	-0.097
URANKER $\uparrow$	-0.092	<b>0.080</b>	-0.092	-0.048
UCIQE $\uparrow$	-0.014	<b>0.012</b>	-0.009	-0.013

Table 2. Evaluation of the sensitivity of performance to LoRA ranks of  $r_U$  and  $r_V$ .

$r_U, r_V$	(8, 8)	(8, 12)	(8, 16)	(16, 16)
UIQM $\uparrow$	-0.063	<b>0.107</b>	-0.042	<b>0.084</b>
URANKER $\uparrow$	<b>0.045</b>	-0.071	-0.022	-0.031
UCIQE $\uparrow$	-0.008	-0.010	<b>0.007</b>	<b>0.008</b>

041 induced enhancement level changes in diverse underwater  
042 scenarios. Both quantitative and qualitative analyses con-  
043 sistently corroborate the conclusions discussed in the Main  
044 Paper.

045 **More results of interpolation methods.** Fig. 5 shows that  
046 the linear interpolation suffers from obvious overexposure.  
047 Overall, using spherical interpolation will give a smoother  
048 result.

049 **Prompts T3, T4 and T5.** “T3: Improve visibility of this  
050 underwater image using level \_\_\_”, “T4: Apply image en-  
051 hancement to the underwater photo up to level \_\_\_”, “T5:  
052 Improve underwater visibility by \_\_\_ levels in total”.

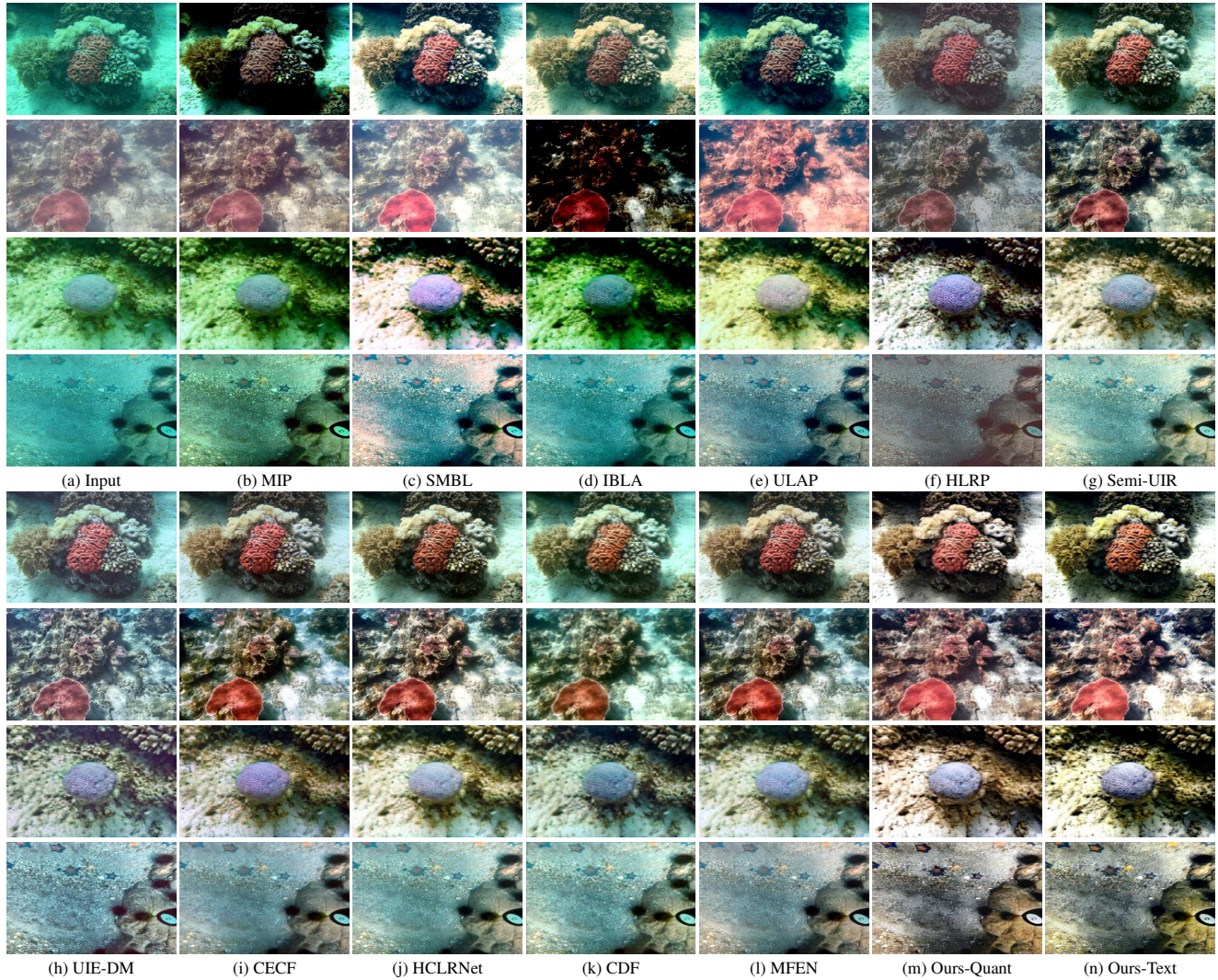


Figure 2. Visual comparisons of SDUIE with other underwater image enhancement methods.

Table 3. Evaluation results under different fusion factors of SDUIE-Quant.

Data	Metrics	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Chan-60	UIQM $\uparrow$	2.863	2.931	3.103	3.345	3.665	4.011	4.433	4.616	4.868	<b>5.057</b>	5.010
	UCIQE $\uparrow$	0.501	0.503	0.509	0.520	0.535	0.550	0.565	0.578	0.588	0.595	<b>0.598</b>
	URANKER $\uparrow$	-0.610	-0.480	-0.229	0.140	0.603	1.100	1.466	1.670	1.780	1.824	<b>1.850</b>
U45	UIQM $\uparrow$	2.095	2.213	2.426	2.739	3.171	3.756	4.435	4.959	5.279	5.444	<b>5.501</b>
	UCIQE $\uparrow$	0.504	0.506	0.513	0.526	0.542	0.556	0.566	0.576	0.586	0.595	<b>0.600</b>
	URANKER $\uparrow$	-0.929	-0.783	-0.503	-0.086	0.479	1.144	1.726	2.066	2.263	2.389	<b>2.478</b>

Table 4. Evaluation results under different levels of SDUIE-Text.

Data	Metrics	zero	one	two	three	four	five	six	seven	eight	nine	ten
UCCS	UIQM $\uparrow$	2.114	2.151	2.316	2.746	3.254	4.023	4.580	4.875	5.070	5.244	<b>5.320</b>
	UCIQE $\uparrow$	0.494	0.497	0.507	0.520	0.530	0.541	0.546	0.551	0.555	<b>0.559</b>	0.558
	URANKER $\uparrow$	-0.908	-0.795	-0.487	0.094	0.659	1.373	1.824	2.057	2.178	2.270	<b>2.297</b>
EUVP	UIQM $\uparrow$	2.643	2.659	2.784	3.071	3.362	3.873	4.182	4.369	4.547	4.703	<b>4.728</b>
	UCIQE $\uparrow$	0.531	0.535	0.546	0.564	0.577	0.591	0.597	0.601	0.604	0.607	<b>0.609</b>
	URANKER $\uparrow$	0.265	0.382	0.670	1.154	1.544	1.941	2.149	2.247	2.306	2.348	<b>2.373</b>

Table 5. Evaluation results under different levels of SDUIE-Text.

Data	Metrics	zero	one	two	three	four	five	six	seven	eight	nine	ten
Chan-60	UIQM $\uparrow$	3.017	2.988	3.132	3.343	3.567	4.005	4.362	4.537	4.652	4.689	<b>4.750</b>
	UCIQE $\uparrow$	0.520	0.521	0.531	0.546	0.562	0.578	0.591	0.602	0.607	0.610	<b>0.611</b>
	URANKER $\uparrow$	0.038	0.101	0.391	0.732	1.105	1.476	1.748	1.934	<b>1.981</b>	1.959	1.895
U45	UIQM $\uparrow$	2.689	2.679	2.864	3.104	3.394	3.804	4.381	4.737	4.861	4.932	<b>4.991</b>
	UCIQE $\uparrow$	0.530	0.532	0.542	0.557	0.573	0.587	0.599	0.609	0.613	0.619	<b>0.620</b>
	URANKER $\uparrow$	-0.056	0.035	0.341	0.719	1.162	1.614	2.015	2.346	2.454	2.490	<b>2.492</b>

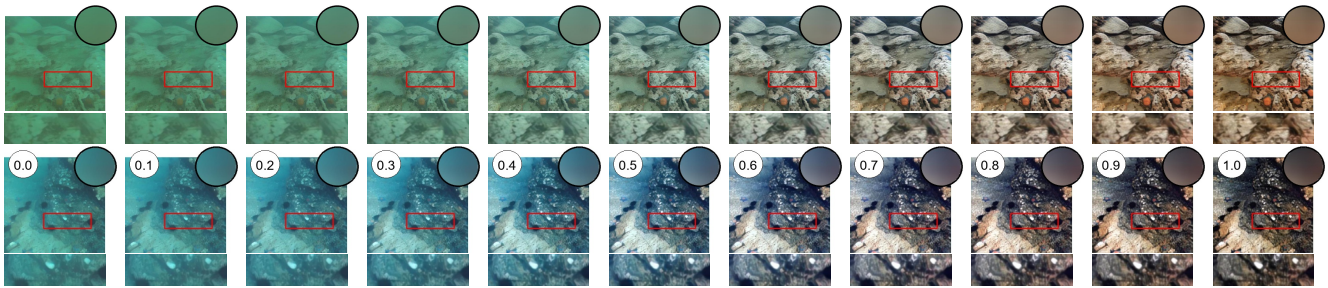
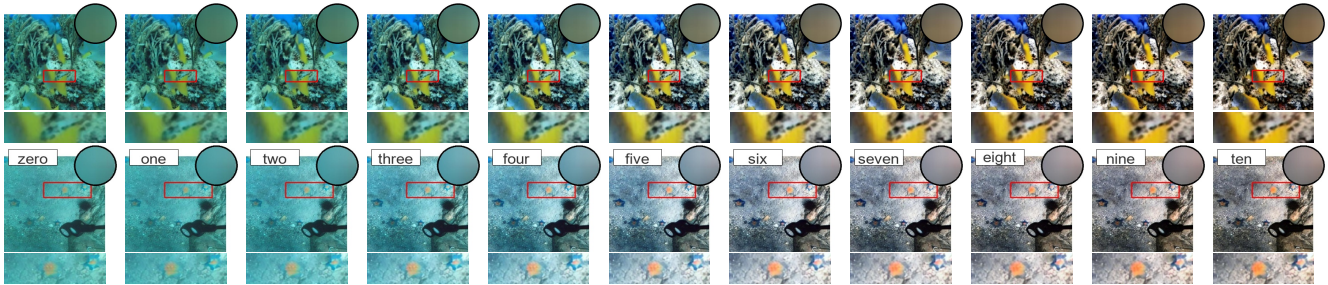
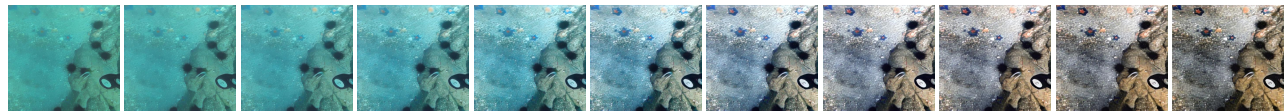
Figure 3. Visual results of SDUIE-Quant under different fusion factor  $\alpha$ .

Figure 4. Visual results of SDUIE-Text under prompts with different level semantics.



(a) Visual results of the linear interpolation.



(b) Visual results of the spherical interpolation.

Figure 5. Comparison of the visual effects of different interpolation methods.

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**References**

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[1] Md Jahidul Islam, Youya Xia, and Junaed Sattar. Fast underwater image enhancement for improved visual perception. *IEEE Robotics and Automation Letters*, 5(2):3227–3234, 2020. 1

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[2] Chongyi Li, Chunle Guo, Wenqi Ren, Runmin Cong, Junhui Hou, Sam Kwong, and Dacheng Tao. An underwater image enhancement benchmark dataset and beyond. *IEEE Transactions on Image Processing*, 29:4376–4389, 2019. 1

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[3] Hanyu Li, Jingjing Li, and Wei Wang. A fusion adversarial underwater image enhancement network with a public test dataset. *arXiv preprint arXiv:1906.06819*, 2019. 1

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[4] Risheng Liu, Xin Fan, Ming Zhu, Minjun Hou, and Zhongxuan Luo. Real-world underwater enhancement: Challenges, benchmarks, and solutions under natural light. *IEEE transactions on circuits and systems for video technology*, 30(12):4861–4875, 2020. 1

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